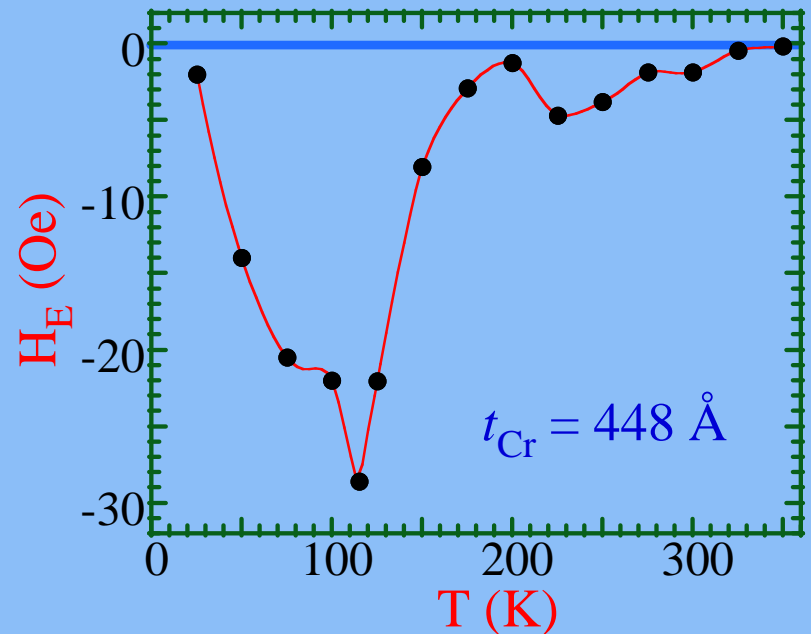


# *Oscillatory* Exchange Bias due to Spin-Density-Wave Antiferromagnet

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Chromium (Cr) is an itinerant antiferromagnet with incommensurate spin density waves (SDW) along the  $\{100\}$  directions. In bulk Cr, transverse and longitudinal SDW exists above and below the spin-flip temperature  $T_{\text{SF}} \approx 123$  K respectively. These intriguing aspects have been extensively studied. We report the first observation of SDW using exchange bias using coupling of SDW to a conventional ferromagnet.

We have fabricated epitaxial  $(100)\text{Cr}/\text{Ni}_{81}\text{Fe}_{19}$  bilayers to observe these effects using exchange bias. Oscillatory exchange bias field ( $H_E$ ) has been observed due to the incommensurate spin-density waves in antiferromagnetic (100)Cr layers. Above  $T_{\text{SF}}$ , we have also observed effects due to SDW with an expanding wavelength. These results reveal the SDW of Cr and key aspects of exchange bias.



Longitudinal  
SDW

$T_{\text{SF}}$

Transverse  
SDW

$T < T_{\text{SF}}$

$T > T_{\text{SF}}$

F. Y. Yang\* and C. L. Chien, "Oscillatory Exchange Bias due to an Antiferromagnet with Incommensurate Spin Density wave,," Phys. Rev. Lett. **90**, 147201 (2003).

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## **Name Written on Hair**

**Lauranne Lanz (Oakland Mills High School)**

**C. L. Chien, Johns Hopkins University, DMR0101814**

Ms. Lauranne Lanz, a high school student from Oakland Mills High School, spent several weeks in the summer of 2002 in the lab of Professor C. L. Chien to use a focused laser beam as a dry etching tool.

The setup consists of a pulsed excimer laser, focusing lenses, and an XYZ sample stage to move the specimen. The pulsed excimer laser beam effectively performs dry etching by ablating material from the illuminated spot.

Ms. Lanz wrote a computer program to control the lateral movement of the XYZ sample stage and the triggering pulses for the laser light so that each sub-pattern or letter can be separately written.

After successfully etched patterns and words of decreasing sizes onto flat surface, Ms. Lanz decided to try to etch her name on a piece of hair. After several attempts, she successfully wrote "Lauranne" on her own hair as shown.



Scanning electron microscope image revealing the word "*Lauranne*" etched onto the hair of Lauranne Lanz (Oakland Mills High School).